Summary of NCAT Test Track Findings

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The NCAT test track was built to develop and evaluate better ways to design and construct hot mix asphalt (HMA) pavements. The track has been in service since 2000. A number of findings have been identified and implemented by individual states, and other findings are being developed as work continues. The ongoing research at the track continues to provide valuable information regarding pavement materials and mixtures, construction procedures and structural pavement design.

The test track research can be divided into two cycles of tests. The first cycle began in 2000 with loading of forty-six test sections. The only variable among the sections in the first cycle of tests was the properties of the mixtures in the top four inches. This cycle of tests was completed in 2002 after ten million Equivalent Single 18-thousand pound Axle Loads (ESALs) had been applied to the sections. The traffic level is representative of 20 years of traffic on many rural Interstate highways.

The second cycle of tests began in 2003 when parts of the test track were reconstructed. Eight sections were removed full depth and reconstructed to provide different thicknesses of HMA. Some of the structural sections used modified asphalt, and others used non-modified asphalt in adjacent sections. Fourteen sections were milled and overlaid with a new mix to be evaluated. The remaining sections were left in place to evaluate the effect of two more years of traffic (another ten million ESALs) and the effect of an additional two years of exposure on durability.

The most significant findings at the conclusion of the first cycle of tests as well as the interim findings for the first five million ESALs of the second cycle of tests are briefly summarized here. The details of this research along with the data and analysis can be found in other reports.

Some of the areas in which findings have been implemented include: high precision diamond grinding to remove bumps, fine-graded vs. coarse-graded mixtures, effect of binder grade on rutting, evaluation of structural characteristics of HMA pavements, performance of SMA and OGFC mixtures, performance tests to predict rutting, improved performance through increased asphalt content, validation of accelerated loading facilities, effect of aggregate properties on performance, comparison of existing design procedure to Superpave, and secondary benefits.

High Precision Diamond Grinding

During construction and maintenance of HMA there are times that high areas in the pavement surface need to be leveled. A good way to do this is to use high precision diamond grinding, but there has been some concern about how well these areas will perform when subjected to traffic and environmental conditions.

At the test track, eleven of the transverse joints built during the original construction and several additional ones built during the reconstruction had to be treated to remove a bump at the joint. The grinding process performed on these joints resulted in a very smooth surface that could hardly be felt when driving over them. None of the treated joints had any performance issues during the initial two years of traffic. Some of these leveled areas have now been in place for up to five years with no performance problems. No sealing was provided to these treated surfaces.
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Fine-Graded vs. Coarse-Graded Mixtures

With the implementation of Superpave specifications in the mid 1990's, most agencies began to emphasize the use of coarse-graded mixtures. The early Superpave requirements encouraged the use of coarse-graded mixtures, especially for high volume roadways.

Since the inception of Superpave, some coarse-graded mixtures have experienced permeability problems. This permeability generally seems to be due to inadequate density. Typically fine-graded mixtures that are a little low on density do not have permeability problems, however, coarse-graded mixtures do appear to have permeability problems when the density is a little low.

mixtures were allowed on lower volume roads (less than 10 million design ESALs), but coarse-graded mixtures were required for higher levels of traffic. As a result of work at the track and at its own accelerated loading facility, the state of Florida now allows fine-graded mixtures to be used on all traffic level projects.

Effect of Binder Grade on Rutting

Superpave guidelines recommend that the high temperature PG grade be bumped for higher traffic volume roadways to minimize rutting. One of the purposes of the first cycle at the track was to look at the effect of bumping the high temperature grade. Several comparison sections were built with the binder grade as the only variable. The results from the first cycle of testing indicated that on average, there was more than a 50 percent reduction in permanent deformation when the high temperature grade was bumped from PG 64 to PG 76. This information is helpful in performing life-cycle cost analysis for modified vs. non-modified asphalt binders. As a result of this information some states have increased the number of projects where grade bumping is specified.

Also a result of this work, Florida has specified the use of PG 76-22 in the top structural layer for traffic level D and in the top two structural layers for traffic level E.

SMA and OGFC Mixtures

SMA mixtures have been used in the US for almost 15 years with very good results. A requirement to use only crushed stone makes these mixes expensive in states with limited crushed stone availability and, in effect, prevents their use.

Evaluations at the track using crushed gravel in an SMA mixture showed that the SMA mixture had less cracking than a similar mixture designed using Superpave requirements. Both sections provided good resistance to rutting. As a result of this finding, Mississippi has now begun placing gravel SMAs in an effort to improve the performance of HMA mixtures with locally available materials. This finding has also led Tennessee to place its first section of SMA containing crushed gravel aggregate.

Due to these problems, many states have had concerns about which type of mixture (coarse-graded or fine-graded) to use. The results of several side by side comparisons at the track have shown that the amount of rutting expected is approximately the same for coarse-graded and fine-graded mixes.

Based on work at the test track, the state of Alabama has changed its specifications to require that fine-graded mixes be used on their high volume roadways. The track showed that these mixes would provide good resistance to rutting and would also minimize the permeability problem.

North Carolina has also revised its specifications to allow more fine-graded mixtures to be used. The contractor is now given the option to use either fine or coarse-graded mixes and the decision is usually fine-graded mixtures since they are more work to use and easier to compact.

When Florida adopted Superpave, fine-graded mixtures were produced with neat, SBS-modified and SBR-modified binder. All these sections were built with the same aggregate sources. As a result of this and other research at the track, Alabama has since changed its specifications to include more widespread use of both SMA and OGFC. Alabama believes that the improved durability of the SMA and the permeability of the OGFC make these mixes very desirable for the higher traffic volume roadways. Based on the performance of the OGFC sections, Tennessee has developed plans to construct its first OGFC mixture. OGFC mixtures have clearly demonstrated (on the track and elsewhere) the ability to remove rainwater from the surface of roadways making them much safer during wet conditions.

Oklahoma is beginning to specify SMA on projects. The test track work, as well as SMA performance in other states, has bolstered their confidence in the SMA mixture.

Performance Tests

There is great interest in the pavement engineering field to identify a reliable test that can predict rutting performance. NCAT conducted several performance tests on the mixtures placed at the track including dynamic modulus, repeated load tests and wheel tracking tests. Although the rutting of test sections at the track is low, it is be-
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lieved that sufficient rutting was observed to determine if trends between the performance tests and rutting exist. The results showed that the dynamic modulus had no correlation with rutting. The confined repeated load test and the wheel tracking tests did have trends with rutting.

As a result of the testing at the track, the Oklahoma DOT has gained confidence in its newly-implemented APA specification. That confidence would have taken 10 or 15 years to develop without some type of accelerated testing, making it unlikely that this confidence would have ever been obtained without the work at the test track.

Increased Asphalt Content

Generally speaking, it is desirable to use as much asphalt as possible without causing rutting or bleeding. Based on results from the test track, Alabama has determined that more asphalt can be added to its mixtures by reducing the number of gyrations for mix design, without causing problems. This higher asphalt content results in improved durability leading to a longer pavement life.

Tennessee is also evaluating mixtures to determine if more asphalt can be added without causing rutting problems.

Validation of Accelerated Loading

Two sponsors of the track work, Florida and Indiana, also utilize their own accelerated loading facilities. It is important that the performance measured using these accelerated loading devices be similar to that expected on the roadway. The NCAT test track offers an opportunity to calibrate the other accelerated loading devices to what would be expected on the roadway.

Indiana’s participation included work to validate the testing performed with Purdue’s accelerated pavement testing APT device. Materials were hauled to the Purdue test facility after construction at the NCAT Track had been completed. A local contractor produced and placed the mixes in Purdue’s indoor facility, which was then used to apply accelerated loading through a mechanized loaded truck tire. It was found that relative differences in rutting between various test sections measured at the Purdue facility were similar to the differences observed at the NCAT Track, which validated the use of the APT for conducting local rutting comparison studies at reduced cost. The State of Indiana is now evaluating the ability of the APT to provide pavement response data similar to that measured in the test track structural experiment sections.

The state of Florida has validated its HVS in comparison to various sections at the track. The Florida DOT validated the HVS for a number of mix types and continues to look at the comparison of results between the test track and the HVS.

Effect of Aggregates

Aggregate tests generally do not correlate well with performance. Most aggregate specifications used by states have been derived over time with limited data. One property, LA Abrasion, has been used to classify aggregate quality for many years though it is doubtful that there is a strong correlation between abrasion and performance.

Some aggregates have been excluded from use in South Carolina because the LA abrasion loss exceeds the state’s specification requirements. One of these sources of aggregates was used in an HMA mixture and placed on the track for evaluation. No significant production problems were encountered during construction, no significant macrotexture changes were observed, and rutting performance was similar to that of other sections with acceptable materials. Based on the results of these tests, South Carolina has changed the specifications to allow the use of this aggregate source with higher LA abrasion losses.

South Carolina also evaluated another source of aggregates that had little record of use. Based on work at the track the DOT determined that this aggregate polished under traffic and therefore was not acceptable for use in surface mixes. Testing the aggregate on the test track allowed the aggregate to be safely tested without having to place and test it on an active highway.

Mississippi and Tennessee constructed sections to look at blending limestone into gravel mixes to determine effects on performance and skid resistance. At the conclusion both states verified that they can make mixes with all crushed gravel that will provide good performance. Friction tests on the test track sections also provided valuable data which Mississippi used to increase the amount of limestone allowed in surface mixtures from 30% to 50%.

Mississippi is evaluating the performance of a 4.75 mm mix and based on the performance will decide whether to use this finer mixture on existing roadways. South Carolina has begun to allow the use of smaller nominal maximum aggregate size mixtures in surface mixes.

Comparison of Mix Designs

Oklahoma has compared the performance of Superpave mixes to their pre-Superpave designed mixtures. At the time these sections were built, Oklahoma did not have experience with Superpave methodology and was eager to facilitate an objective field comparison. Although both mixes exhibited good field performance, slightly less rutting was observed in the Superpave section. The test track results gave Oklahoma the incentive to move forward with adoption of Superpave based on a more realistic evaluation than could be done in a laboratory study.

Secondary Benefits

While the primary purpose of the track is to conduct the specific studies funded by the track sponsors, the track has supported much additional research to solve national and local problems. Some of this work has involved effects of various mixtures on noise, friction, permeability, compactibility and performance testing. For example the primary data for NCHRP 9-27, which developed recommendations for the minimum thickness of HMA layers, was developed during reconstruction of the test track. Work at the track is developing data that can be used in the design of perpetual pavements.

Several states have made mix adjustments or adopted other mix types such as SMA or OGFC over performance of some of the mixes at the track. Even though each sponsor has built 4-2 test sections to provide answers to specific questions, each sponsor also has access to the data generated by all of the other states. This has significantly improved the confidence of the sponsors to make needed modifications to mixtures without having to build test sections on their own highways where cost, safety and time required would be concerns.

Summary

The implementation of findings from the NCAT test track has resulted in a considerable savings to each state through the use of improved materials, mixtures, design procedures or construction methods. Testing is continuing and additional findings will be developed as the tests progress.

Accelerated performance testing at the track has provided answers to many questions that would have taken many years on the highway system and would have created safety problems during the research period. The test track has offered a safe, accelerated method to accomplish research that otherwise would have to be conducted over a long period of time in a manner that is very expensive and less safe.
2005 Calendar of Events

May 6 - 9  AASHTO Spring Meeting
Seaview Marriott Hotel and Spa
Galloway, New Jersey
Website: http://transportation.org/aashto/calendar.nsf

June 14-23  NCAT Professor Training
Auburn University
Auburn, AL
Contact: Vinnie Hester, vinnie@eng.auburn.edu, (334) 844-6228 ext. 107

Sept. 15-20  AASHTO Annual Meeting
Gaylord Opryland Hotel
Nashville, TN
Website: http://www.transportation.org/aashto/home.nsf/FrontPage

Nov 1-3  Quiet Asphalt 2005 Conference/Workshop
Holiday Inn Select
Lafayette, IN
Website: http://widget.ecn.purdue.edu/~sqdh

Nov. 15-16  NCAT Test Track Symposium
The Lodge at Grand National
Auburn, AL
Contact: Carol Mims, ctapley@eng.auburn.edu, (334) 844-6228

Dec 13-15  Southeastern Asphalt User/Producer Group
Sheraton Music City Hotel
Nashville, TN
Website: http://seaupg.org/

The National and Regional Superpave Newsletters are published three times a year and are coordinated by the North Central Superpave Center.

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